Electronic Version
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Claims

[c1] A barrier for use in an interconnect, the barrier comprising:
a nickel-rich nickel-copper (NiCu) layer electrically connected to a device terminal of the interconnect, the device terminal including a recess for receiving the nickel-rich nickel-copper layer, the nickel-rich layer including a higher percentage of nickel than copper; and
a copper-rich nickel-copper (NiCu) layer electrically connected to the nickel-rich NiCu layer and a solder joint of the interconnect, the copper-rich NiCu layer including a higher percentage of copper than nickel.

[c2] The barrier of claim 1, wherein the nickel-rich NiCu layer includes greater than approximately 90% nickel, and the copper-rich NiCu layer includes greater than approximately 90% nickel.

[c3] The barrier of claim 1, further comprising an intermediate alloy layer between the nickel-rich NiCu layer and the copper-rich NiCu layer.

[c4] The barrier of claim 3, wherein the intermediate alloy layer includes a higher percentage of copper than the

nickel-rich NiCu layer and a higher percentage of nickel than copper-rich NiCu layer.

[c5] The barrier of claim 1, wherein the solder joint includes one of: tin (Sn) and eutectic lead-tin (PbSn).

[c6] The barrier of claim 1, wherein the device terminal includes one of: titanium-tungsten (TiW), chromium-copper (CrCu) and copper (Cu).

[c7] The barrier of claim 1, wherein the recess has an aspect ratio no less than 0.5 and no greater than 2.

[c8] An interconnect comprising:
a device terminal, including a recess in a surface thereof, for electrically connecting to a semiconductor device;
a solder joint electrically connecting the device terminal to another structure; and
a barrier between the device terminal and the solder joint, the barrier including:
a nickel-rich nickel-copper (NiCu) layer electrically connected to the recess of the device terminal, the nickel-rich NiCu layer including a higher percentage of nickel than copper, and
a copper-rich nickel-copper (NiCu) layer electrically connecting the nickel-rich NiCu layer and a solder joint of the interconnect, the copper-rich NiCu layer including a

higher percentage of copper than nickel.

[c9] The interconnect of claim 8, wherein the nickel-rich NiCu layer includes greater than approximately 90% nickel, and the copper-rich NiCu layer includes greater than approximately 90% copper.

[c10] The interconnect of claim 8, further comprising an intermediate alloy layer between the nickel-rich NiCu layer and the copper-rich NiCu layer.

[c11] The interconnect of claim 10, wherein the intermediate alloy layer includes a higher percentage of copper than the nickel-rich NiCu layer and a higher percentage of nickel than copper-rich NiCu layer.

[c12] The interconnect of claim 8, wherein the solder joint includes one of: tin (Sn) and eutectic lead-tin (PbSn).

[c13] The interconnect of claim 8, wherein the device terminal includes one of: titanium-tungsten (TiW), chromium-copper (CrCu) and copper (Cu).

[c14] The interconnect of claim 8, wherein the recess has an aspect ratio of no less than 0.5 and no greater than 2.

[c15] A method of forming a barrier for an interconnect, the method comprising the steps of:
bathing the device terminal in a single nickel-copper bi-

nary bath;

forming a nickel-rich nickel-copper (NiCu) layer on a device terminal of the interconnect including in a recess of the device terminal while providing no agitation to the bath, the nickel-rich NiCu layer including a higher percentage of nickel than copper; and

forming a copper-rich nickel-copper (NiCu) layer on the nickel-rich NiCu layer while providing agitation to the bath, the copper-rich NiCu layer including a higher percentage of copper than nickel.

[c16] The method of claim 15, wherein the forming steps include further include:

applying a first current to the device terminal to form the nickel-rich NiCu layer; and

applying a second current to the device terminal to form the copper-rich NiCu layer.

[c17] The method of claim 16, wherein the first current is higher than the second current.

[c18] The method of claim 17, wherein the first current is approximately 10 to 50 mA/cm2 and the second current is approximately 0.5 to 5 mA/cm2.

[c19] The method of claim 15, wherein the forming steps also form an intermediate alloy layer between the nickel-rich

NiCu layer and the copper-rich NiCu layer.

[c20] The method of claim 15, wherein the nickel-rich NiCu layer includes greater than approximately 90% nickel, and the copper-rich NiCu layer includes greater than approximately 90% copper.